

5 GOLF TRAINING AID APPARATUS

CROSS-REFERENCE TO PRIOR APPLICATION

The present application is a continuation-in-part of U.S. Utility Application Serial No. 09/997,728 filed 30 November 2001.

BACKGROUND OF THE INVENTION

10 1. Field of the Invention

The present invention relates to a sports swing training apparatus. More specifically, the present invention relates to a golf training device that assists a user in attaining the proper
15 alignment of a piece of equipment with an object to be struck during a user's swing.

2. Description of the Related Art

In prior attempts such as that set forth in U.S. Pat. No. 5,374,063, the disclosure of which is
20 specifically incorporated herein by reference, a training golf club is disclosed. The device uses discreet components in conjunction with infrared sensors, among other things, to provide a user with feedback in the form of LED indicators to promote the proper club face alignment. This is accomplished by reflecting infrared beams off of a golf ball back to
25 sensors.

There are several drawbacks associated with the design disclosed. First, after the ball is struck, the target golf ball quickly speeds away. This results in the LED indicators turning off since the golf ball is needed to reflect infrared back to the sensors. This, in turn, prevents the golfer from receiving information as to the alignment of the club face with respect to the ball
30 at the time of impact since, again, the impact of the club with the ball results in the termination of the indicator lights. This problem is especially present where swing speeds can be around 70-100 mph for clubs other than putters and where the duration of the swing may last for several seconds.

5 In addition, the infrared technology of the prior art training aid cannot be used in outdoor applications. This is the result of the infrared generated by the sun interfering with the device's ability to operate.

SUMMARY OF THE INVENTION

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The present invention concerns a club for impacting an object, which may have a club head that has a club face. At least one microprocessor in communication with a plurality of infrared sources, and a plurality of infrared sources, are also provided. The plurality of infrared sources and indicators are configurable in a configuration indicating proper club face
15 alignment and a configuration indicating club face misalignment. The infrared sources are periodically pulsed by a microprocessor between an activated and deactivated state. The sensors are configured on the club head to receive infrared from the infrared sources and to generate a signal in response to the infrared received. The microprocessor is programmed to receive signals from the sensors when the infrared sources are activated. The microprocessor
20 is programmed to activate the indicators in an aligned or misaligned configuration.

A golf club embodiment of the invention uses a club head having a club face that has a plurality of infrared sources on the club face. There is a first regulator for regulating the plurality of infrared sources and a plurality of infrared sensors on the club face. A second regulator regulates the bias current of the plurality of infrared sensors. A filter on at least one
25 of said sensors filters received signals, said sensors being configured on said club head to receive infrared signals from said infrared sources. There is a processor for receiving filtered signals from said infrared sensors for determining the club face alignment based upon the signals received and indicators configurable to indicate club face alignment activated by said processor.

30 The present invention overcomes the deficiencies noted above. The problem with losing the alignment information upon impact is solved by freezing the alignment information at the moment of impact for later use by the user. The second problem of not being able to use the device outside is solved by the use of a circuit which ignores the infrared generated by the sun and which selectively focuses on the infrared beams generated by the device.

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5 BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, objects and advantages of the present invention will become apparent from the following description and drawings wherein like reference numerals represent like elements in several views, and in which:

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FIG. 1A is a schematic diagram of the circuitry used with a first embodiment of the present invention.

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FIG. 1B is a schematic diagram of the circuitry used with a second embodiment of the present invention.

FIG. 2 is a representation of a pulsed signal generated by the present invention for use with the infrared LEDs.

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FIG. 3 is a graphical representation of the voltage applied to the infrared LEDs.

FIG. 4 is a schematic illustration of a preferred embodiment of the invention wherein the training device is a golf club head which is in a preferred alignment with a golf ball.

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FIG. 5 is a schematic illustration of the preferred embodiment of the present invention wherein the golf club head is misaligned with a golf ball.

FIG. 6 is a partial cross-sectional view with portions removed to illustrate a club having an impact surface and a cavity in which a sounder is located.

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5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Set forth below is a description of what are currently believed to be the preferred
embodiments or best examples of the invention claimed. Future and present alternatives and
modifications to the preferred embodiments are contemplated. Any alternates or
10 modifications in which insubstantial changes in function, in purpose, in structure or in result
are intended to be covered by the claims of this patent.

The present invention comprises a swing training aid 110 which may be a putter, driver, iron,
wood type of club or some other device that has a club head 116 such as a tennis racket,
15 baseball bat, hockey stick, and other types of equipment. However, for ease of reference, the
embodiment concerning a golf club will be primarily referred to in this specification. A shaft
14 may also be provided. The club has a face or surface 140 that impacts an object such as
ball 22. The circuitry used to operate the device's electronics may be housed in a cavity of
club 116, elsewhere in the club such as handle 14, or in a combination of places.

20
FIG. 1A shows the circuitry used with the present invention. At the center of the circuitry is
microprocessor 10 which is in communication with a number of circuits. The microprocessor
10 in FIG. 1A and Fig. 1B employ the Microchip PIC RISC-based architecture 8-bit CMOS
microcontroller, wherein FIG. 1A uses the PIC12C672 device including a 4-channel, 8-bit
25 on-board analog to digital converter peripheral, and the schematic of FIG. 2B employs the
PIC12C508A device.

One circuit is designed to freeze the Red indicator LEDs 154 and 155 in either an aligned
signal or configuration as well as a misaligned signal or configuration as shown in FIGS. 4
30 and 5. Red LED light pipes are provided to allow the Red LEDs 154 and 155 to be
positioned to facilitate placement of the circuit board within the cavity of the club head 116.
The circuitry of FIG. 1B also shows a Green LED 456 positioned as an ON/OFF indicator via
a Green LED light pipe for viewing on the club head 116.

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5 FIG. 4 indicates that the golf ball 22 has been squarely struck since both indicators 154 and 155 are illuminated. FIG. 5 shows a misaligned hit. Only indicator 154 is illuminated which indicates a toe-in alignment or that the club face 140 was closed at impact. If indicator 155 was only illuminated, it would indicate that the club face was open at impact.

10 The circuit includes a piezo sounder 300 located in golf club head 116 in cavity 302. When surface 140 of the golf club head 116 strikes a golf ball, the impact causes the sounder 300 to generate a voltage which is directed through op/amp 306 to create a digital signal that is fed to the microprocessor 10. Once the microprocessor receives the signal it freezes the information it is currently receiving from the other components of the invention as to the
15 position of the club face with respect to the golf ball. This information is frozen for a predetermined period of time. In one preferred embodiment the amount of time is between 2-6 seconds with 4 seconds being the most preferred.

As shown in FIG. 1A, the voltage or signal generated from sounder 300 may be directly fed
20 to the microprocessor. However, it has been found that a base voltage may also be applied to one line of the op/amp via resistors 307 and 308, with the feedback connected to the op/amp via resistor 309. In this embodiment, once the sounder 300 creates a voltage upon impact, op/amp 306 amplifies the signal which is fed through diode 311 to microprocessor 10. Capacitor 313 also charges and then discharges through resistor 315, so that a continuous
25 signal of predetermined length is provided to the microprocessor. This is done as a result of finding that, in some instances, the signal generated by the impact may occur too quickly for detection by the microprocessor.

In FIG. 1B, a pushbutton switch 450 is provided on the circuit board, and a pushbutton key-
30 cap for operating the pushbutton switch 450, (see FIGs. 4-5) allow activation of the pushbutton 450 from a location on the club head of 116. The schematic of FIG. 1B includes a buffer circuit 452 having hysteresis zone for receiving the switched input from pushbutton 450. The output of the buffer 452 is provided to the 2A clock input of a D-type flip-flop 454, which provides circuitry for reliable on/off activation. The hysteresis input buffer 452 and
35 flip-flop 454 operate to provide push-button de-bounce circuitry. The described circuitry has been found advantageous for positioning the pushbutton switch 450 at the club head 116

5 rather than the club handle to prevent accidental turn-on. The circuitry allows the momentary switch of pushbutton 450 to operate as a toggle switch.

Another circuit used with the present invention concerns supplying power to infra-red (IR) LEDs 138 and 139 in a more efficient manner and in a manner which allows for operation in
10 an outdoor environment. Advantageously, IR LED current regulation is provided with a transistor 458 and associated resistors 460, 462 and 464 for regulation of the current through IR LEDs 138 and 139.

Regulation of the current through the IR LEDs 138 and 139 advantageously reduces ambient
15 temperature dependency of the infrared emitter circuitry. Moreover, the current regulation reduces the battery voltage dependency of the infrared emitter circuitry discussed herein.

It has been found that to increase the device's ability to work outdoors the LEDs need to be
20 a)0 turned on as bright as possible. This, however, leads to power supply problems, in that, as shown in FIG. 3, line 20, the power supplied to the LEDs tends to diminish over time, especially, as will be explained in further detail below, when the LEDs are pulsed at a predetermined rate, with 4 kilohertz being preferred.

To overcome this situation, a capacitor 330 is provided which supplies power to the LEDs as
25 well. The LEDs are turned on and off (pulsed), through the use of transistor switch 332 which is operated by the microprocessor 10. When the LEDs are in an activated state, capacitor 330 supplies power to the LEDs 138 and 139. When the LEDs are in a deactivated state, again through the use of switch 332, capacitor 330 is charged. Using the capacitor in this manner provides a constant power supply to the LEDs as shown by line 30 in FIG. 3.

30 Another circuit used with the present invention aids in the operation of the device in the outdoors where sunlight is present. Circuitry components are utilized to facilitate infrared detection in various environments, including sunlight. Infrared sensors 128 and 129 are phototransistors SFH309/FA-5, which include an optical coding with sensitivity to reduce
35 susceptibility to false triggering in bright sunlight, and thus advantageous as an IR detector component in the described application. As shown in FIG. 1B, IR detector logic comparators

5 468 and 470 provide a detection threshold and reduce ambient temperature dependency of the IR detector circuitry.

Additionally, voltage regulator 472 regulates the VCC voltage at 3.3 volts, also reducing the susceptibility to false triggering in bright sunlight. Calibration potentiometers 474 and 476
10 are used to set trigger points and balances the left and right sensitivity. This facilitates reliable operation in a variable IR ambient environment, as may be generated by florescent lighting and other sources. Sunlight is a problem because its infrared washes out the infrared generated by LEDs 138 and 139 and disrupts the ability of sensors 128 and 129 to receive valid infrared signals from LEDs 138 and 139. The device detects the dimpled spherical golf
15 ball in indoor environments, e.g., on a carpeted surface, or outdoors on grass, sand or various ground surfaces. The device may be used outside, even in the presence of sunlight. By filtering direct current, the false readings caused by sunlight may be reduced. Pulsing the infrared source at, e.g., 2-6 kilohertz, also helps reduce the detrimental effects sunlight has on the operation of the device.

20 Two identical circuits are provided to solve this problem. Since each circuit is the same, reference will be made to the circuit used with sensor 128, with the same design applying to the circuit associated with sensor 129. Once sensor 128 receives infrared from LED 138, it sends a signal through capacitor 360. A capacitor is used because it permits an alternating
25 current signal to pass while blocking out a direct current signal. Since sunlight is, in essence, detected as a direct current signal, the reception of this infrared by the sensor is not mistakenly received by the microprocessor as a false reading. It is filtered out by capacitor 360. The capacitor's ability to separate these two types of currents or signals is also why LEDs 138 and 139 are pulsed at 4 kilohertz so as to create an AC current or signal that will
30 pass through capacitor 360 for detection by microprocessor 10. It has been found through trial and error that a pulse rate of about 2-6 kilohertz is acceptable with a pulse rate of 4 kilohertz being most preferred.

Once the signal is passed through capacitor 360 a two stage amplifier consisting of op/amps
35 364 and 366 is used. Associated with the op/amps are resistors 370-378 which form part of the two stage amplifier. It has also been found that placing a second capacitor 361 between the op/amps, which functions in the same manner as capacitor 360, is also beneficial to the

5 operation of the device in the presence of natural sunlight.

Another way in which the apparatus reduces the effects of sunlight on the device's ability is to program the microprocessor to accept input from sensors 128 and 129 during time periods when LEDs 138 and 139 are activated and to ignore signals received during time periods
10 when the LEDs are deactivated. In another embodiment, not only does the microprocessor only sense a signal from the sensors during activation, it also does so during a specific time period in the cycle. An optical head front plate is provided to allow the optical circuit board to be precisely positioned and calibrated. As shown in FIG. 2, it is desirable for the microprocessor to be programmed to look for a signal during the later half of the activation
15 cycle 400, with the deactivation cycle being designated 401. Programming microprocessor 10 to look for a signal at about point 404 in the cycle further takes into account a finding that the sun causes a phase-shift in the 4 kilohertz AC cycle. Looking for a signal later in the pulse takes this into account. In addition, simply programming the microprocessor to look for a pulse only when LEDs 138 and 139 are activated also reduces errors caused by outdoor use.

20

A computer routine which may be used with the circuitry of the present invention is as follows:

```

;.....
; Initialize values
;.....

movlw 205          ;Set up TMRO to count 100uS for
movwf TMRO         ;pulses at 5KHz and 50% duty cycle
clrf GPIO          ;
;
bcf GPIO,5         ;turn off IR emitters
bcf GPIO,4         ;left LED on
bcf GPIO,2         ;right LED on
;
movlw 248          ;set 1 second delay
movwf X_VALUE      ;
movlw 8            ;
movwf Y_VALUE      ;
movlw 167          ;
movwf Z_VALUE      ;
call waita         ;1 second delay
;
bsf GPIO,4         ;left LED off
bsf GPIO,2         ;right LED off
;
movlw 246          ;set up for 4 second delay
movwf X_VALUE      ;to use later
movlw 35           ;
movwf Y_VALUE      ;
movlw 77           ;
movwf Z_VALUE      ;
;
;.....
; The main routine.
;.....
Main
    btfsc GPIO,5    ;Check for Infrared's on
    goto Main1      ;
    btfsc flag,0    ;see if we should check inputs
    goto Main1      ;no, so get out of here
    bsf flag,0      ;set the flag so we only do this once
;
Left_led    btfss input,0 ;Check for right input
            goto Left_off ;not 'on' so leave here
            bcf GPIO,4    ;turn right LED on
            goto Right_led ;go check for left side
;
Left_off    bsf GPIO,4    ;turn right LED off
;
Right_led   btfss input,1 ;Check for left input
            goto Right_off ;not 'on' so leave here
            bcf GPIO,2    ;turn left LED on
            goto Main1    ;go check for impact
;
Right_off   bsf GPIO,2    ;turn left LED off
;
Main1       btfsc GPIO,3  ;check impact sensor, if 1 then delay
            call waita    ;4 second delay
            goto Main     ;loop back to main
;
;.....
; wait_a
; Function: This routine is a delay loop. The delay
; is set by the equates Z1_VALUE, Y1_VALUE, and X1_VALUE.
;
; The time delay can be calculated using the formula
; below where X,Y, and Z have been used as a shorthand:
;
; Delay = (4+(Z-1)*3) + [(4+(Y-1)*3) + (4+(X-1)*3)*Y]*Z
;
; The retlw adds another 2 clock cycles and calling this
; routine takes 2 cycles to transfer control. Therefore,
; the total time delay generated by 'call wait_a' is
;
; equal to Delay+4 and is given below:
;
; TOTAL DELAY = 4 + (4+(Z-1)*3) + [(4+(Y-1)*3) + (4+(X-1)*3)*Y]*Z
;
; Example: Z:52, Y:101, X:5 ==> 100,001 clock cycles
;.....
waita
    movf Z_VALUE,w
    movwf temp3
wait_a_3    movf Y_VALUE,w
            movwf temp2
wait_a_2    movf X_VALUE,w
            movwf temp1
wait_a_1    decfsz temp1,F
            goto wait_a_1
            decfsz temp2,F
            goto wait_a_2
            decfsz temp3,F
            goto wait_a_3
            return
;
END

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.....
; _CONFIG _CP_ALL & _MDT_OFF & _PWRTB_ON & _INTRC_OSC & _MCLRRE_OFF
;.....
; All of the equates are listed below.
;.....
;Usable Registers: 32 to 127

X_VALUE EQU 32 ;used in waita routine, a loop delay
Y_VALUE EQU 33 ;
Z_VALUE EQU 34 ;...
temp1 EQU 35 ;temp register used in 'waita routine
temp2 EQU 36 ;
temp3 EQU 37 ;...
;
flag EQU 38 ;register to tell when to check inputs
input EQU 39 ;input storage register
; EQU 40 ;
; EQU 41 ;
; EQU 42 ;
; EQU 43 ;
; EQU 44 ;
; EQU 45 ;
; EQU 46 ;
;.....
; Start of Program
;.....

org 0 ;
goto config ;jump around interrupt routine
;.....
; Interrupt Routine
;.....

org 4 ;interrupt vectors here
btfss INTCON, TOIF ;Check if TMR0 overflow
goto int_end ;NO, so get out of here
movlw 210 ;otherwise, set TMR0
movwf TMR0 ;
bcf INTCON, TOIF ;clear the TMR0 interrupt flag
btfss GPIO,5 ;Check for Infrared's already on
goto interrupt1 ;no, so go turn them on
bcf GPIO,5 ;yes, so turn them off
movf GPIO,w ;get the inputs
movwf input ;and save them
bcf flag,0 ;clear the "inputs checked" flag
retfie ;and leave
interrupt1 bsf GPIO,5 ;turn on the Infrared's
retfie ;and leave
int_end movlw B'1010000' ;reset the interrupt control
movwf INTCON ;register and then leave
retfie ;
;.....
; Configure Ports for Analog/Digital Input
;.....
config bcf STATUS,IRP ;register bank select bit for
bcf STATUS,RP1 ;indirect addressing
;
bsf STATUS,RP0 ;select page 1
;

call 07FFH ;get the osc. cal. value
movwf OSCAL ;and save it to the cal. location
movlw B'00000111' ;select no analog inputs
movwf ADCON1 ;configure ports
bcf PIE1, ADIE ;disable A/D interrupts
clrf OPTION_REG ;Set up the option register
bsf OPTION_REG,7 ;
;
bcf STATUS, RP0 ;select page 0
;
bsf INTCON, GIE ;enable interrupt
bcf INTCON, PEIE ;disable peripheral interrupts
bsf INTCON, TOIE ;enable TMR0 Interrupt
bcf INTCON, INTS ;disable external interrupt
bcf INTCON, GPIE ;disable GPIO Interrupts
bcf INTCON, TOIF ;clear TMR0 interrupt flag
bcf INTCON, INTF ;clear external interrupt flag
bcf INTCON, GPIF ;clear GPIO interrupt flag
;
;.....
; Configure Ports for Output/Input
;.....

bsf STATUS,RP0 ;select page 1
;
movlw B'00001011' ;GPIO,GP1,GP3 inputs, rest outputs
movwf TRISIO ;set I/O's
;
bcf STATUS,RP0 ;select page 0
;

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5 In use, the club face or impact surface is positioned behind a ball or other object to be struck
22. To determine if the club face or impact surface is properly aligned, infrared is pulsed
from LEDs 138 and 139. The infrared reflects off of ball 22 and is received by sensors 128
and 129. If microprocessor 10 receives signals from both sensors 128 and 129, LEDs 154 and
155 will be activated as shown in FIG. 4. This indicates proper alignment. For the
10 embodiment involving a golf club, this will be typical when the ball is positioned at the sweet
spot of the club. Misalignment will result in only one of the sensors receiving infrared as
shown in FIG. 5. This will only result in either LED 154 or 155 being activated which,
depending on the LED activated, indicates either an open or closed club face.

15 To be truly useful, the club must also be capable of being swung through a complete stroke
while retaining the ability to inform the user of the orientation of the club face or impact
surface at the time of impact. As mentioned above, this is not possible in current designs. For
example, as described above, with respect to a golf club embodiment, once the golf ball is
struck, the source for reflecting the infrared back to the sensors is no longer present which
20 results in the indicators being turned off. To take this into account, once the microprocessor
receives a signal from sounder 300, the information that is currently being received by the
microprocessor 10 as to the orientation of the club face is frozen and held for a predetermined
amount of time. This allows a user to perform a take-away and then complete a full swing,
which often results in the club being positioned at the user's back upon completion. To review
25 the stroke, the user must unwind and only then can the results be examined. Moreover, the
golfer typically does not see the indicators at the time of impact since the golfer's focus is on
swinging the club even for the slower speed putting strokes. This is also especially true for
swings using other clubs such as irons, woods and drivers, baseball bats, hockey sticks and
tennis rackets, which may reach speeds up to 100 mph, or more. Freezing the information
30 obtained in the manner described above creates a useful training aid.

While the preferred embodiments of the present invention have been illustrated and
described, it will be understood by those of ordinary skill in the art that changes and other
modifications can be made without departing from the invention in its broader aspects.
35 Various features of the present invention are set forth in the following claims.